A risk model for collection preservation

Robert Waller
Canadian Museum of Nature
Box 3443, Station D
Ottawa, Ontario K1P 6P4, Canada
E-mail: rwaller@mus-nature.ca

Abstract

A model describing the preservation system within an institution responsible for cultural property is presented. The model describes a series of nested systems and subsystems relating specific risks to an institution's role within society. At the detail level, specific risks are deconstructed into modes of failure, events or processes, and causative or precursor events, processes or states. Having a complete model facilitates consideration of specific issues from a higher level, metamodelling perspective.

Keywords

risk assessment, risk management, preservation, model, preventive conservation

Introduction

In the past 10 years, there has been considerable interest in and development of ideas about how the preservation of cultural property can benefit by adopting a risk assessment model (Waller 1994, Michalski 1994, Ashley-Smith 1999). There appears to be a growing consensus that this approach will improve the effectiveness of preventive conservation. The purpose of this paper is to describe the risk model for preservation employed at the Canadian Museum of Nature (CMN). It involves both the application of system science to describing the role of preservation in an institution and the detailing of failure modes that lead to the loss of collection value.

In her book on conservation management, Keene (1996) provides a brief history of system science and applies the soft systems analysis approach of Checkland and Scholes (1990) to the museum preservation system. She includes all aspects of conservation within her definition of the preservation system. The model described here is the result of a similar initiative but is significantly different. Most notably, the CMN model focuses on the preservation function, defined as the management of risk to collections. It includes the contributions of other organizational groups, such as registration and facilities management, to the preservation function. This model sets aside restoration or remedial conservation that is directed at restoring lost value, regardless of whether that value was lost before or after an artefact entered the museum. Those activities are instead considered part of the collection development function.

This work is a departure from the traditional focus of conservation on monitoring of collection condition. Such reporting can identify some types of current progressive damage and, over time, might clearly demonstrate continuing damage and loss. Information from these surveys can provide some guidance for planning the preservation activity of an institution. It is, however, often too little information too late for preventing damage or loss. Forecast risk, rather than measured damage to property, is the appropriate measure to manage the preservation function of a museum. Measurement of collection condition over time will provide verification (or not) of the efficacy of the preservation function, but it does not by itself provide sufficient information to monitor or plan the preservation function.

The CMN collection risk model has the stochastic or probabilistic detail similar to that of a Failure Modes and Effects Criticality Analysis (FMECA) hierarchy at the lowest levels but the characteristics of a soft system conceptual model at the higher levels. In this way, the model serves to describe the means by which technical control of a parameter or an issue at the detailed working level is realized as a benefit to humanity at the highest model level.

Model description

The CMN risk model is a series of systems and subsystems, as shown in Table 1.

The description of this model begins at the level of a specific risk and proceeds from there first through higher levels of model (see Figure 1) and then to lower levels of model. First, the term *specific risk* refers to a particular kind of damage or loss to a collection unit due to a specific cause. The specific risk is the sum of any

Table 1. Systems and subsystems of the CMN risk model.

System	Subsystems (components or factors)
Society	institution, education system, research system, etc.
Institution	collection, research, education, operations
Collection management	development, use, preservation
Preservation	collection units, generic risks
Collection unit risk	generic risks to collection unit
Generic risk to collection unit	specific risks to collection unit
Specific risk	modes of failure
Mode of failure	event or process
Event or process	causative or precursor event, process or state
Causative or precursor event, process or state	secondary causative or precursor event, process or state
etc.	etc.

and all ways (modes of failure) in which that risk might be realized. This will be discussed again with the benefit of an example, but first let us consider higher modelling levels as depicted in Figure 1.

The next higher model level collects a variety of specific risks into what is called a generic risk. A generic risk could also be thought of as a kind of hazard. In past CMN risk assessments, each generic risk has been the cross of an agent of deterioration (Michalski 1990) and a type of risk (Waller 1994). Collecting data on specific risks into groupings of generic risks facilitates reporting of data. In the future, it may be advantageous to have multiple possible hierarchies for organizing specific risks.

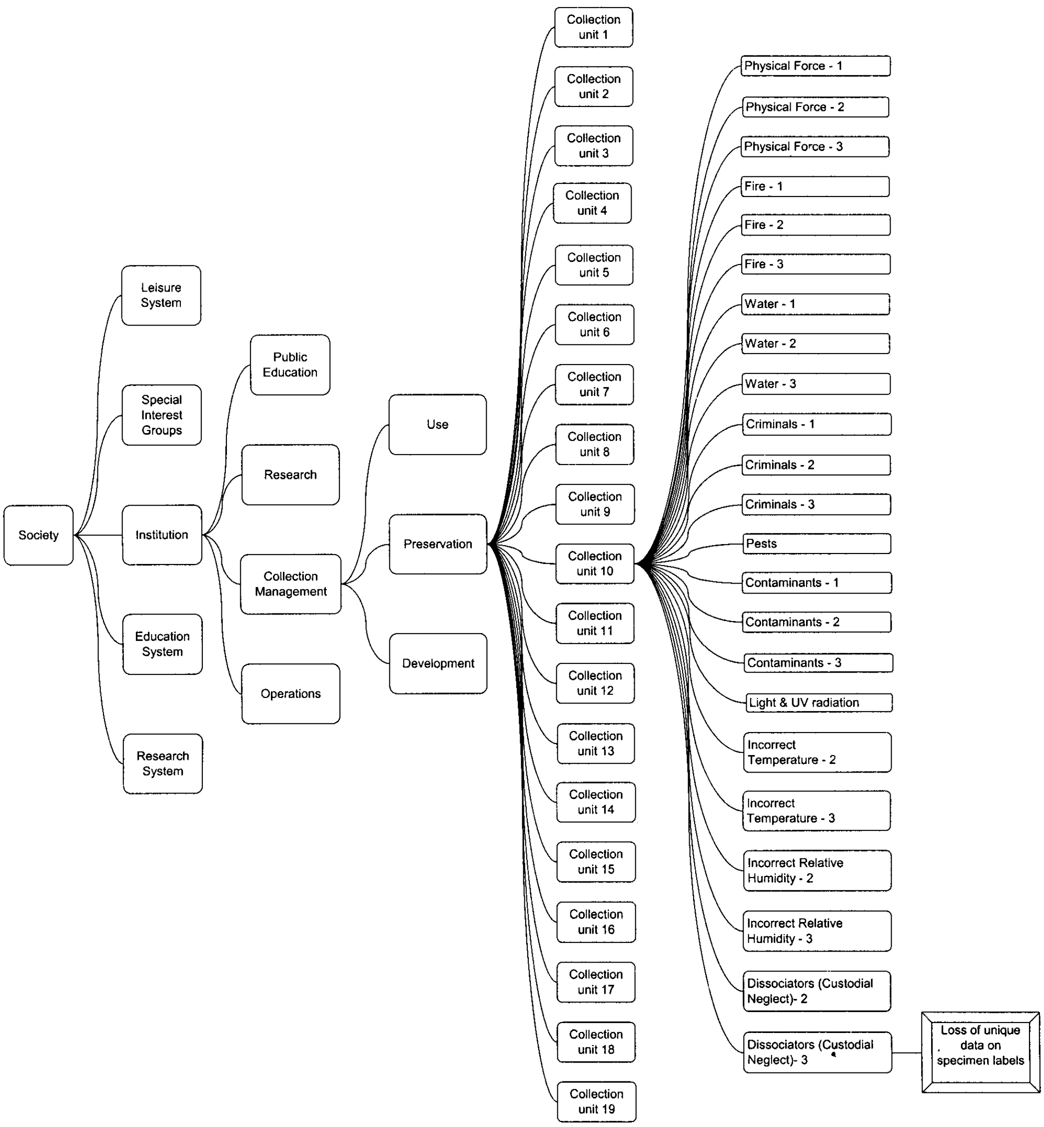

Figure 1. Higher level model structure depicting conceptual levels above specific risk

Above the generic risk level is the total risk to a single collection unit. Dividing an institution's holdings into units to be assessed provides one level at which the distribution of risk across an institution's holdings is resolved. An ideal number of collection units is thought to be about 10, although the number chosen may range from 1 to 100, depending on the variability of collections and considering such criteria as management, uses, materials, environment and so forth.

The sets of risks to collection units comprise the preservation system, which is taken to mean the management of risks to a cultural property to a tolerable level of risk. Risk is the appropriate measure for the preservation function since it is the forward-looking measure related to preservation. In contrast, measures of collection condition are backward-looking in that they reflect past damage. From a decision theory viewpoint, risk is also the appropriate measure for the preservation function as it is blind to the vicissitudes of chance occurrences (i.e. luck).

The quality of management of preservation should, therefore, be judged by the efficiency of mitigation of forecast risk more than by actual prevention of damage and loss, as measured after the fact. At first thought, this may seem inappropriate. Is it really fair that a preservation management program could be judged as being excellent even if the outcome is a high rate of damage or loss from the collection being preserved? Yes, it can be fair and appropriate. The field of decision analysis recognizes the importance of separating judgment of the quality of a decision from the quality of the outcome (Spradlin 1999).

For example, Crumly (1984) reports a case of a German museum that, during the Second World War, relocated its most valuable collections to the basement of a large brewery. Regrettably, a bomb that fell down an airshaft destroyed this material while the remaining lower value collections in the museum building survived unscathed. This unfortunate outcome should not alter our estimation of the quality of the decision to move valuable collections to what was considered a safer location.

In the next higher model level, we put the preservation system together with the two other major systems of collection management, specifically collection development and use. I do not mean to imply any hierarchical relation among *collection management*, *conservation* and related terms such as *curation* or *collection care*. Using the definitions and scheme employed here, however, collection management is a broader system that incorporates preventive conservation within its preservation subsystem and remedial conservation within its development and use subsystems. Institutions may adopt administrative organizational structures that do not reflect these functional subsystems. However, for collection management to function properly, these subsystems must operate. For them to operate well, it is important that we identify all significant boundaries and interactions between these subsystems of collection management.

Again moving one level higher, we see that the collection management system exists alongside, and interacts with, the research, education and operations systems (such as finance and facilities management). This is a somewhat different modelling view than that taken by Williams and Cato (1995), since it incorporates further evolution in our understanding of collection management as a system (Cato et al. 1996).

Finally, at the top level of this model we situate the institution within society at large. Where needed, it is possible to insert other model levels. For example, the interrelations of different but related institutions, fields of endeavour, political regions and so forth could be considered as an intermediate level between the levels of the institution and of society. Above the level of society, one could distinguish the interrelationships of various societal groups within a larger system of humanity. This may be an important consideration where diverse groups have strong interests in certain objects or collections (e.g. Clavir 1994).

Returning our attention to the 'specific risk' model level, let us consider lower, increasingly detailed levels of modelling. This modelling is related to, yet differs from, the industrial practices of Fault Tree Analysis (FTA), Reliability Block Diagrams (RBA), Failure Modes, Effects Analysis (FMEA), and Failure Modes, Effects and Criticality Analysis (FMECA) and others (e.g. Fullwood 2000).

Figure 2. Example of an attached specimen label in the CMN bird study skin collection

As one example of a specific risk, consider the risk of loss of data from labels attached to individual bird study skin specimens. Figure 2 shows a typical example of an attached specimen label. This specific risk may occur as the result of any of

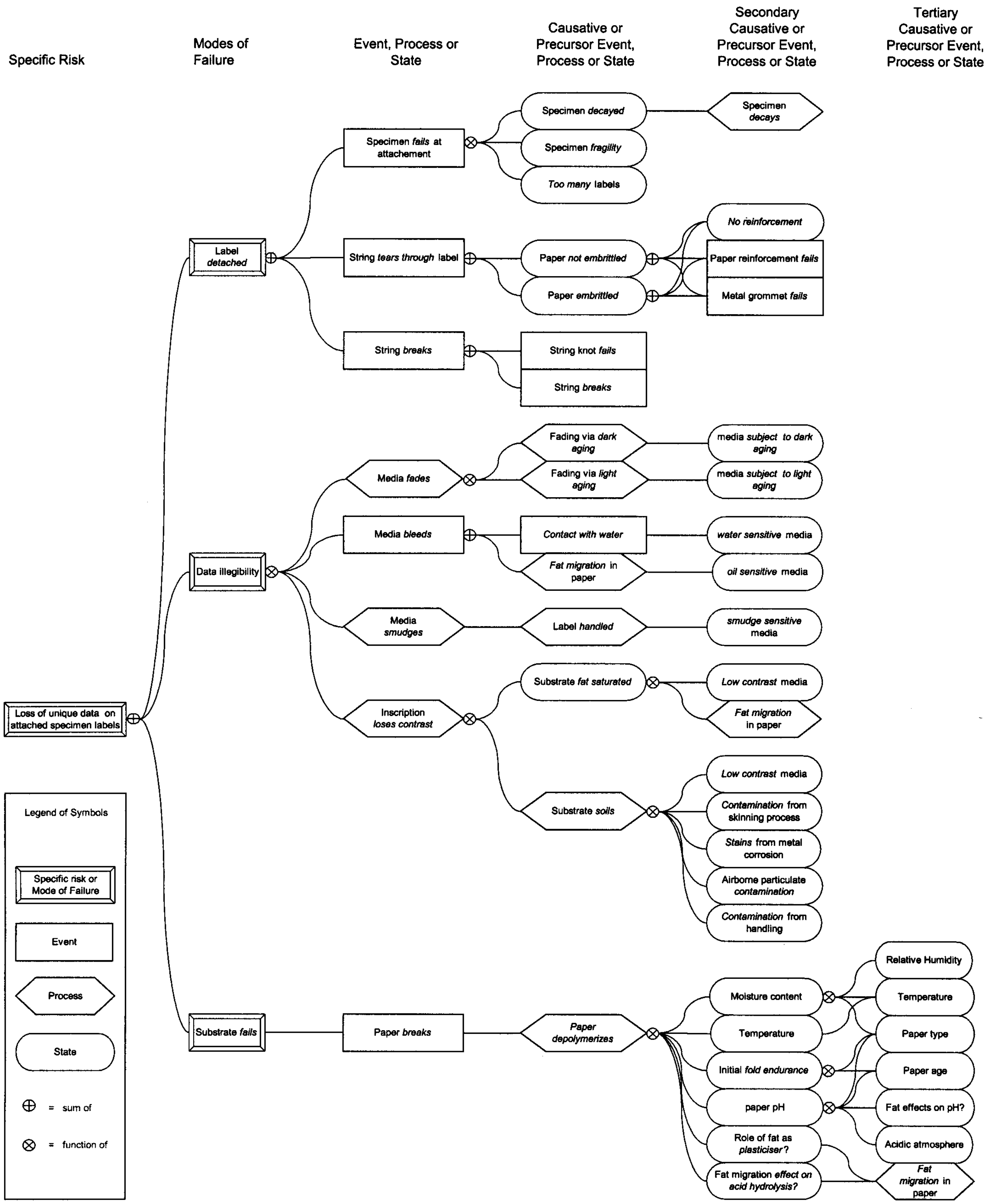

Figure 3. Lower level model structure depicting detail levels below specific risk

several modes of failure. Figure 3 depicts this and other more detailed levels of the model.

At the level below, mode of failure, we identify all known events or processes that would result in a particular mode of failure. In the bird-label example, the mode of failure 'label detaches' can be arrived at through any of three events while the mode of failure 'data becomes illegible' can be arrived at through any of four processes. An event is simply a process that is completed in a fixed period of time. The distinction between an event and a process depends on the time scale considered and it will in some cases be arbitrary.

In the next model level, one or more causative or precursor events, processes or states leading to, or contributing to, an event or process are identified. Using the 'data becomes illegible' mode of failure and the 'data media bleeds' event as an example, we see here that this event can be the result either from contact with water or migration of oil through the label.

Consider the case in which the concern is fat migration through the paper affecting an oil-impermanent data-recording medium. In a quantitative analysis, this node of the model represents the fraction of all labels that we expect will be subjected, at some time over the next century, to oil migration to an extent that would render a water-impermanent inscription illegible. Past extents can be estimated by considering the distributions of extent of fat saturation as a function of service age of label. These, after adjustment for changes in rates of collection development and methods of specimen preparations, can be used to forecast expected new instances of fat migration.

At progressively lower, more detailed model levels, secondary causative or precursor events, processes or states leading to, or contributing to, events, processes or states are identified. In the case of the process of fat migration through the paper-label substrate causing bleeding of the data-recording medium, we see that having an oil-impermanent data-recording medium is an essential precursor state.

In this downward direction of model development, ever increasing levels of deconstruction and technical analysis can be conducted in our attempt to describe the detailed pathways through which a risk is realized. In a complete model, the lowest layers can be dedicated to particular sets of factors such as control features or environmental factors. That is not a necessary feature of the model but does offer a means of eventual integration with emerging information that relates environmental factors to object rates of damage, building characteristics to specific risks and so on.

Discussion

In the CMN approach to risk analysis for collection preservation planning, we employ the model outlined here in a top-down approach to assessing risks. We define the scope and general design of the risk assessment in the appropriate model levels. At the specific risk level any risks considered significant enough to evaluate are identified and precisely defined. Also at this level we estimate the magnitude of the specific risk to the collection unit by estimating the parameters 'fraction susceptible', 'loss in value', 'probability' and 'extent' (Waller 1994). These estimates are the basis for focusing our attention, depending on the relative significance of specific risks to collection units.

Based on these findings, one of several courses of action may be taken. Known high magnitude risks might be mitigated immediately. Risks that might be high in magnitude but are uncertain are analyzed further. This will generally mean more detailed modelling under that specific risk and obtaining and evaluating data to make the detailed model quantitative for that specific risk. Finally, for risks that are found to be low in magnitude, with sufficient certainty, we need only ensure that they remain low.

We do not strive to eliminate risk. Instead, we manage risk to a level such that the normative choice is to make no further investments in risk reduction. In other words, we strive to sub-optimize the preservation system so as to optimize systems at higher levels (e.g. collection management, institution and society) (van Gigch 1974). Our ability to think from the higher level, metamodelling perspective facilitates thinking about conservation issues from a broader perspective (van Gigch and Rosvall 1991). This modelling strategy also strives to integrate conservation of cultural property with other institutional and societal needs to seek new opportunities for synergism (Rosvall et al. 1995).

Finally, an aspect of this model that might be controversial is that remedial conservation activities are not considered part of the preservation function unless they are required to achieve stability. For example, de-acidification of objects subject to autocatalytic acid hydrolysis is considered part of the preservation function. Repair or restoration of objects as a result of use-related wear or damage is considered part of the use function. Repair or restoration of newly acquired objects is considered part of the development function. Repair or restoration required as a result of failure of the preservation function is also considered part of the development function. There are two reasons for this. One is that the management decision of whether or not to invest in repair or restoration should take into account whether it might be more cost effective to acquire a different object than to repair or restore the first. Of course, all costs for de-accessioning of the damaged object and acquisition of the new object will need to be considered in this decision. The second, and more important, reason is that having the cost of remedial conservation appear as a collection development cost makes the failure of the preservation function more evident to management. This encourages management understanding of the fact that preservation functions supported by finite resources will always result in some level of failure. That encourages a healthy level of frankness and honesty in negotiations for resource allocations for preservation.

Conclusion

The CMN risk model allows a comprehensive system view of the preservation function. It permits both attention and resources to be focused on issues of greatest importance.

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